Nantucket Harbor Water Quality
Annual Report
2004

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Introduction:

Nantucket Harbor is comprised of three large basins each connected by a narrow race-way with two additional lobes or Polpis Harbor. Nantucket Harbor has an approximate surface area of 5,250 acres and basin volume of 50, 990 acre-ft (Knoecklein 1998). Within Nantucket Harbor, Polpis Harbor has a surface area of 177 acres and basin volume of 923 acre-ft (Knoecklein 1998). Polpis Harbor is a nutrient and bacteria source for Nantucket Harbor.

Water quality has been monitored since 1990. Water quality results indicate that nutrients are being recycled in the Head of the Harbor; Polpis Harbor has contributed to the decline in water quality in Quaise Bain; the mooring field area in some years is a large source of phosphorus.

Nantucket is not alone in the degradation of harbor water quality. There have been serious declines in water quality in all coastal communities due to anthropogenic nutrient overloading. Although coastal ecosystems have the capacity to assimilate some level of nutrient input without major changes in the ecological health, most coastal communities have exceeded this ability.

As nitrogen and phosphorus concentrations increase, the natural eutrophication process is accelerated. This process results in excessive aquatic plant growth, particularly in poorly flushed, shallow coastal embayment. As this over abundant plant growth dies, its decomposition uses up the available dissolved oxygen and creates anoxic conditions. Nutrients are released from the sediments into the water column. The continued addition of nutrients and acceleration of plant growth leads to further decomposition by anaerobic bacteria (bacteria that don't require oxygen). The result is an embayment bottom coated with an organic mud residue (i.e. Wauwinet, Polpis, Quaise, Pocomo flats) and a habitat, once desirable for shellfish and finfish, now unsuitable for spawning and growth.

During the years 2000-2004, the Marine and Coastal Resource Department biologists, Tracy Curley and Keith Conant, gathered nutrient information for Nantucket harbor and its' watershed drainage basin. Harbor sampling includes temperature, dissolved oxygen, salinity, water transparency, water quality constituents (nitrogen and phosphorus), and phytoplankton. The water quality stations are as follows: **station 1 Mooring Field**, **station 2 Quaise Basin**, **station 3 Head of Harbor**, **station 4 Nantucket Sound**, **station 5 Polpis West**, and **station 6 Polpis East**.

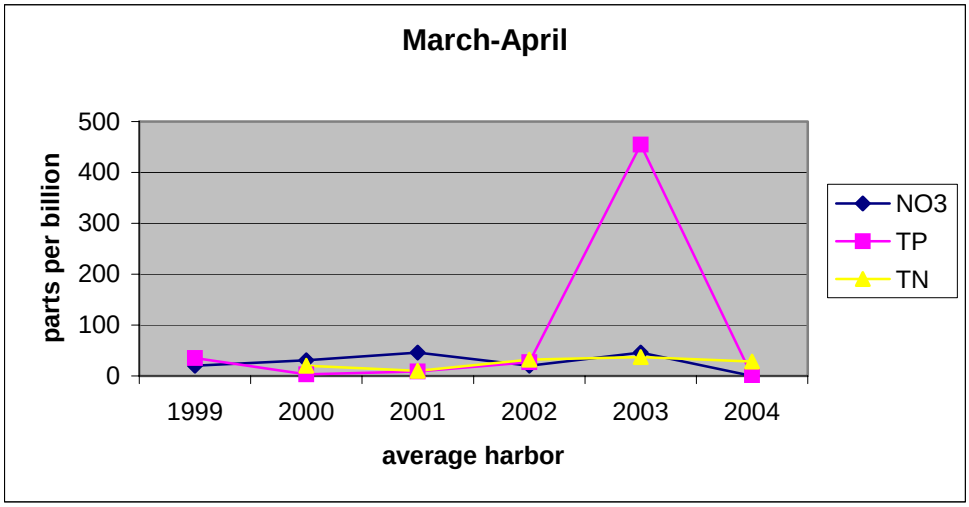
Harbor Monitoring Results:

Nutrients (Nitrate, Total Phosphorus, Total Nitrogen)

To determine the extent of nutrient loading the following water quality standards have been recommended. For total nitrogen concentrations, TN found below 300 ppb is considered excellent water quality. TN detected in the 300 ppb to 390 ppb is considered good water quality. TN measured from 390 ppb to 500 ppb is moderate. TN found in the range of 500 ppb to 700 ppb is considered to be significant impaired. TN found above 700 ppb is severely degraded water quality.

For Nantucket Harbor in the years of 2000 to 2004 during the spring, average total nitrogen concentrations ranged from 20 ppb to 37 ppb indicating excellent water quality for that parameter. Nitrate concentrations have ranged from non detect to 46 ppb falling in the moderate quality range. Excellent water quality describes dense eelgrass, plentiful shellfish and

Figure 1 Average Nutrient Measured in Parts per Billion during the Spring



high oxygen levels for fish. Moderate water quality describes some eelgrass, moderate shellfish stocks and rare oxygen depletion.

Nantucket Harbor has experienced some loss of eelgrass beds in the last ten years. Since 1993, the Coastal Zone Management has monitored eelgrass in Nantucket Harbor. We have provided the CZM with secchi depth records for the past ten years in hopes to determine ocular conditions required to maintain current eelgrass beds. Ocular conditions are a function of nutrient concentration availability in the harbor.

Total phosphorus that exceeds 50 ppb in a water body is considered to be impaired. Total phosphorus has exceeded, on more than one occasion, safe water quality standards. In

the spring of 2003, total phosphorus was recorded at 455 ppb and was non detect in spring 2004. One might consider this total phosphorus spike to be in laboratory error; however, we have observed phosphorus spikes during the spring and/or fall in different years. In August 1999, total phosphorus was recorded at 282 ppb (Figure 2). In August for most years, total phosphorus was recorded at or above 50 ppb. In September in 2001, total phosphorus was 171 ppb and in 2003, 111 ppb (Table 1).

Figure 2: Average Nitrates and Total Phosphorus 1999-2004

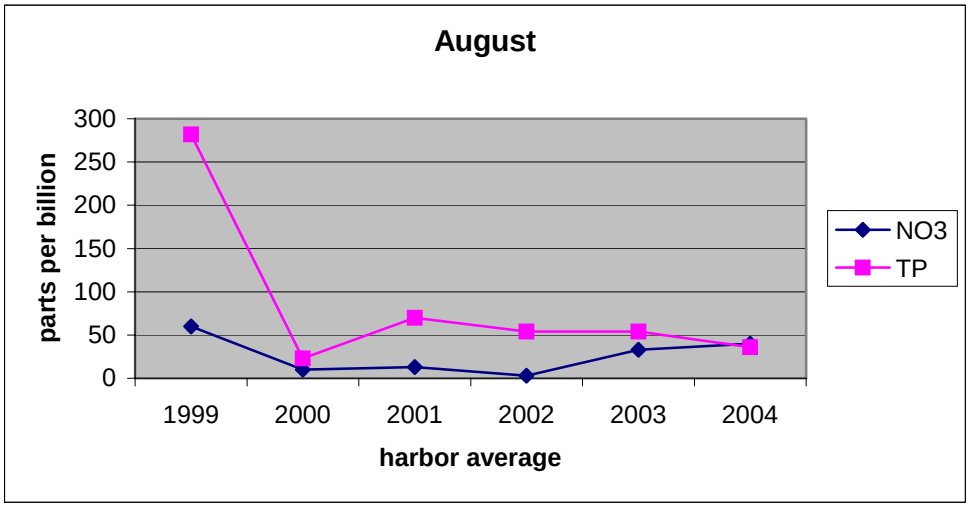


Table 1: September Average Nitrate and Total Phosphorus concentrations (ppb) for six harbor sites.

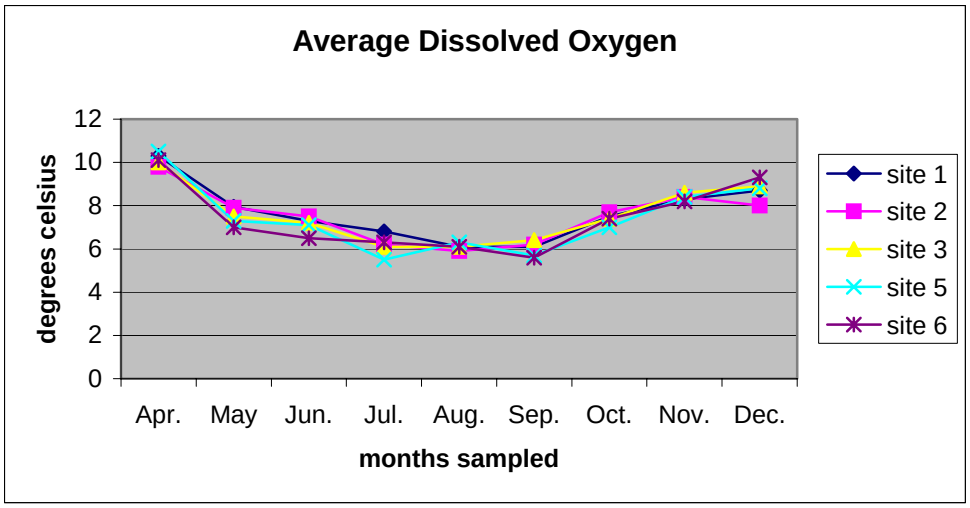
	1999	2000	2001	2002	2003	2004
NO3	na	47	63	na	13	0
TP	na	58	173	na	111	0

In the years of 1999 and 2002, nitrate and total phosphorus concentrations were unavailable. Although September in 2002 was not sampled, total phosphorus recorded on August 2, 2002 was 57ppb and 43 ppb on October 23, 2002.

Dissolved Oxygen

The physical effect of water temperature is also important when considering water quality. At high water temperatures, the solubility of oxygen is low and therefore the concentration of dissolved oxygen in the water column is reduced. Colder water contains more dissolved oxygen gas. During July, dissolved oxygen was the lowest for the year due to the high water temperature and the solubility of oxygen.

Figure 3: Dissolved Oxygen 2004



In the month of July, the dissolved oxygen concentration was hypoxic (4ppm – 6ppm) on the bottom in the three basins. These low dissolved oxygen levels depict an oxygen demand created by biological processes not the solubility of oxygen. Dissolved oxygen was higher in the remainder of the water column. Overall, average dissolved oxygen levels were good for harbor sites in 2004.

Temperature and salinity:

To better understand nutrient loading and internal recycling, it is important to determine if sections of Nantucket Harbor stratify. Stratification generally results from a combination of physical and chemical parameters. Colder and more saline water sinks to the bottom of the water column. During the summer, biological respiration can have severe impacts on dissolved oxygen concentrations in the bottom layers of water. The normal impacts of stratifications in concert with increased nutrient loading will increase biological production and decreased dissolved oxygen levels in the bottom layer of stratified water. Low oxygen for long periods of time is detrimental to the benthic communities.

In 2004, Nantucket Harbor was frozen in January. Temperature in the spring was approximately 5C. Temperature increased throughout the summer and peaked in July at 23C. Temperatures remained high through the summer (19-22C) and began to decrease in the fall. In November, an exchange of surface and bottom water occurred as water temperatures became almost isothermic. Water temperature decreased to a low of 6C in December.

Figure 4: Average Water Temperature for Harbor Stations and Nantucket Sound 2004

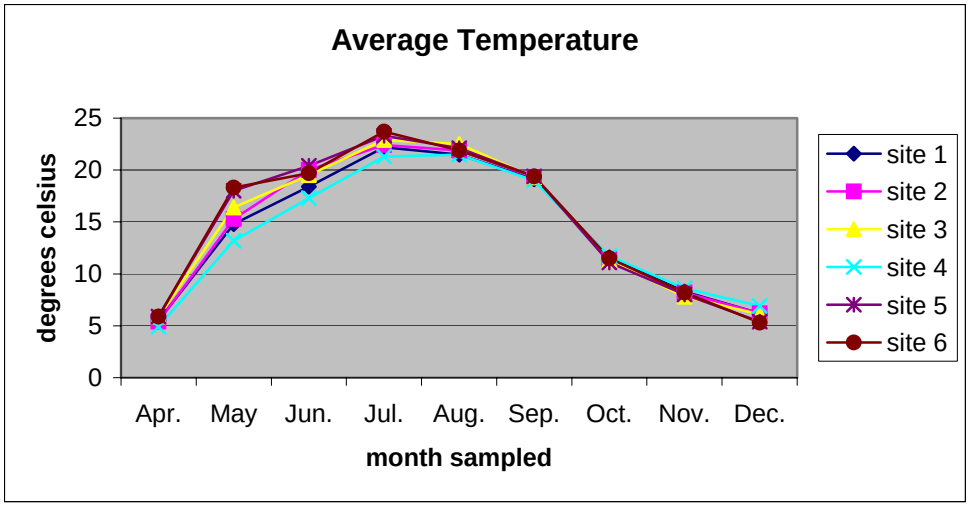
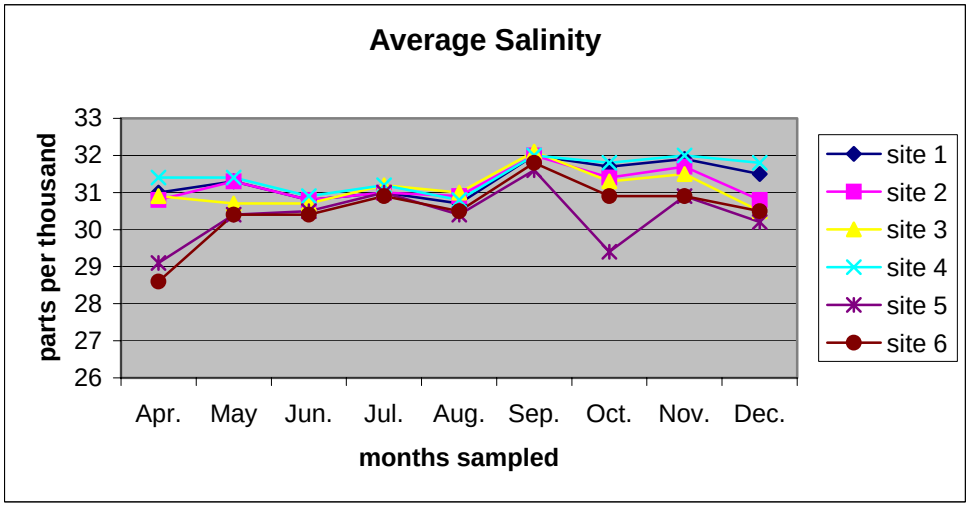


Figure 5: Average Salinity for Harbor Stations and Nantucket Sound 2004

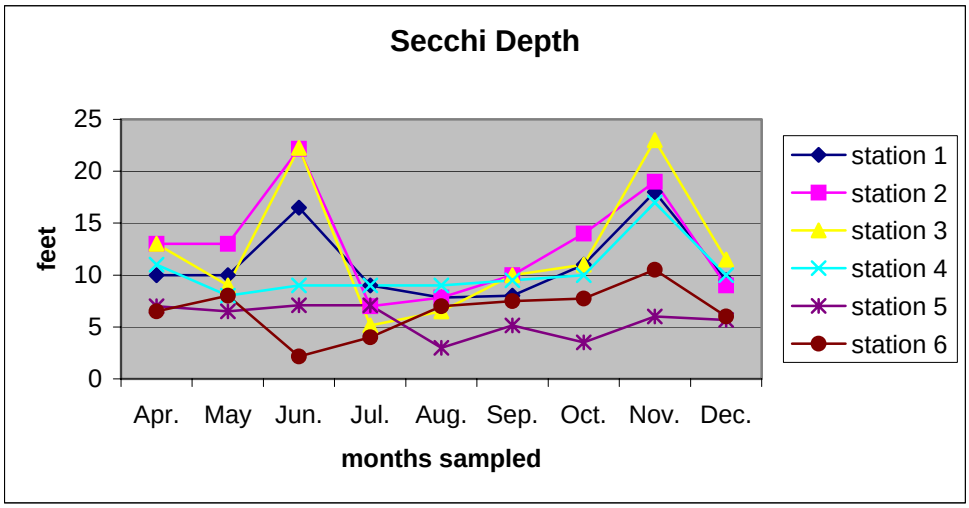


The mooring field (site 1) had the highest salinity in the harbor due to the close proximity to Nantucket Sound. Salinity at Wauwinet (site 3) was slightly lower than Quaise Basin (site 2) due to location in the harbor. Wauwinet receives fresh water inputs from surface and groundwater sources. Polpis Harbor is the least saline due to the shallow nature of the harbor, circulation and fresh water input. The greatest salinity gradients are found in Polpis Harbor.

Secchi Depth

Secchi depth is an approximate measure of water transparency. The secchi depth is a measure of the quality of particulate material suspended in the water column. Secchi depth is a good estimate of the density of phytoplankton populations.

Figure 6: Secchi Depth for Nantucket Harbor and Nantucket Sound 2004



Nantucket Harbor historically experiences two periods of water clarity, generally in April and October. This year, the two periods of water clarity were later. Harbor water cleared in June and November. Nantucket Sound was clear in April and again in November.

In July, the Head of the Harbor had hypoxic levels of dissolved oxygen in the bottom layer of water causing the possible internal recycling of nutrient and resultant phytoplankton bloom. Secchi depths were lowest in July for all the months sampled. Low Secchi depth in June at station 6 was due to shallow water depth not turbidity.

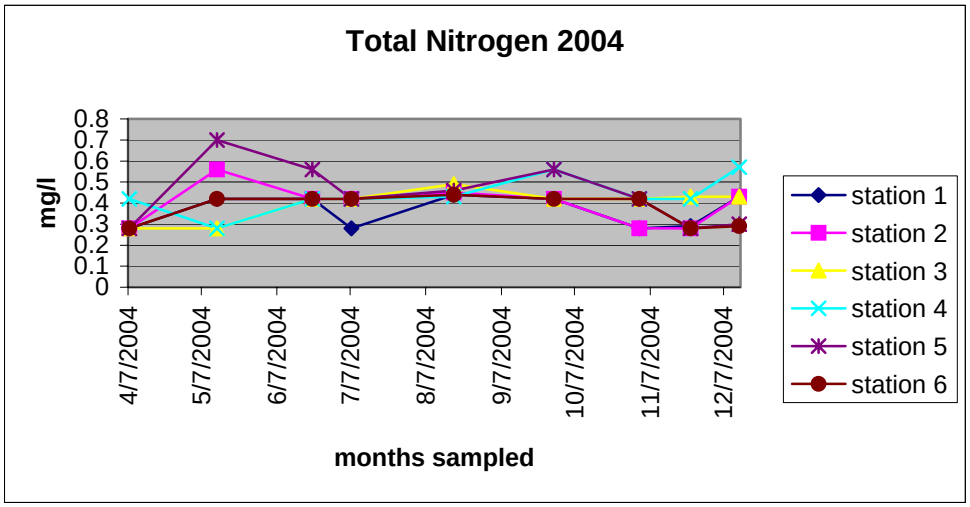
The pattern of alternating periods of good and poor water clarity appears to be a trend in Nantucket Harbor. Generally, water transparency reaches a maximum in April and again in November. Secchi depth generally reaches a low in February and July. The winter secchi minimum corresponds to a diatom bloom and in the summer a dinoflagellates

bloom results in a decrease in secchi depth in most stations as nutrient concentrations increase.

Nitrogen

Nantucket Harbor is a marine system and therefore is nitrogen limited. It is nitrogen that determines the amount of plants (phytoplankton, submerged aquatic vegetation) than can grow. Blooms of bluegreen algae and other detrimental algae proliferate when too much dissolved inorganic nitrogen is present in the water body. Inorganic nitrogen is comprised of nitrite, nitrate, and ammonia. Nitrogen has a complex set of oxidation states in water that can yield a number of different forms of nitrogen. Generally total nitrogen above 600ppb (0.6mg/l) and dissolved inorganic nitrogen above 150ppb (0.15mg/l) indicate eutrophic water.

Figure 4: Total Nitrogen



Total Nitrogen fell in the moderate range according to water quality standards for nitrogen. The mooring field station had a total nitrogen range from 0.28mg/l to 0.44mg/l for the sample year. Total nitrogen at site 1 was more consistent than in 2003. In the months of May through November, total nitrogen alternated between 0.28mg/l to 44mg/l every two months but did not reach eutrophic levels. The Quaise station had a total nitrogen range from 0.28mg/l to 0.56mg/l. Total nitrogen in Quaise did not reach eutrophic levels this year. Wauwinet had a total nitrogen range from 0.28mg/l to 0.49mg/l. Nantucket Sound had high total nitrogen levels ranging from 0.28mg/l to 0.57mg/l. Total nitrogen was highest in December in the Sound. Polpis West had higher total nitrogen levels than Polpis East again this year. Polpis Harbor exceeded eutrophic levels for nitrogen in May. The nitrate and nitrite fractions were tested together so all

nitrate data includes nitrite. Nitrate for the 2004 sample year was non detect for most months sampled.

Total Phosphorus

Phosphorus was initially made available to living organisms through the weathering of rocks. Phosphorus is found in the environment as a form of soluble phosphate ions. Phosphate, which is applied to a lawn as fertilizer, becomes bound to soil particles. Phosphorus is a major eutrophication contaminant in surface water of fresh water bodies. Principal loading is due soil erosion. Phosphorus can enter the harbor through groundwater.

To date, phosphorus concentrations have exceeded (0.05mg/l) on more than one occasion since 1998 indicating enriched conditions. Phosphorus concentrations are rising with more frequency at more sample stations. This year, phosphorus was lower than in years past. However, in August and November at Polpis Harbor total phosphorus was at eutrophic levels.

Total phosphorus was non detect in the months of April, June, July, August, early November and December. Phosphorus was present in May, August, and November. Fertilizers are generally applied in the spring (May) and again in the fall (October or November). The time of year when phosphorus is present in the water column appears to the same time as when fertilizers are applied.

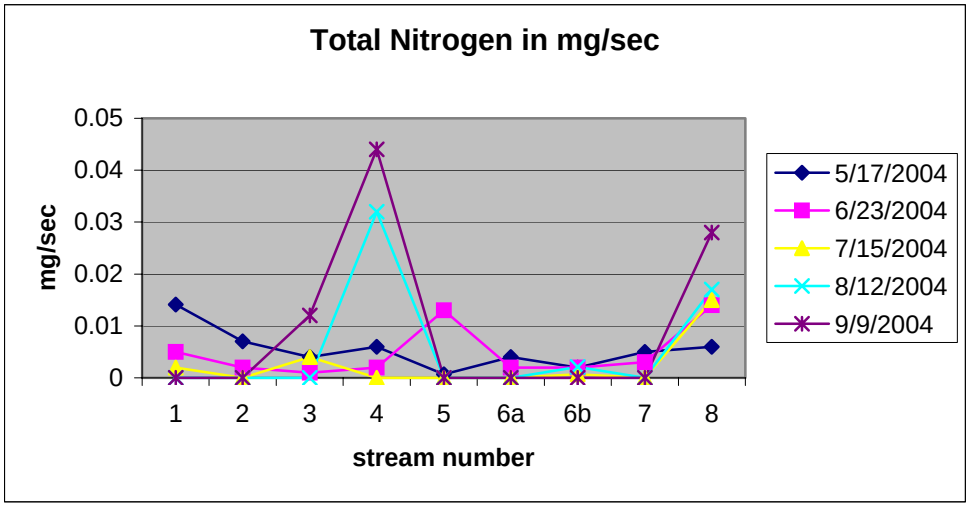
Total phosphorus ranged from 0.018 mg/l to 0.035 mg/l in May. In August, total phosphorus ranged from 0.022 mg/l and 0.053mg/l. In November, total phosphorus ranged from 0.016 mg/l to 0.055 mg/l. The highest phosphorus concentrations were detected in Polpis Harbor with the exception of one high reading in May in Wauwinet.

Stream Data

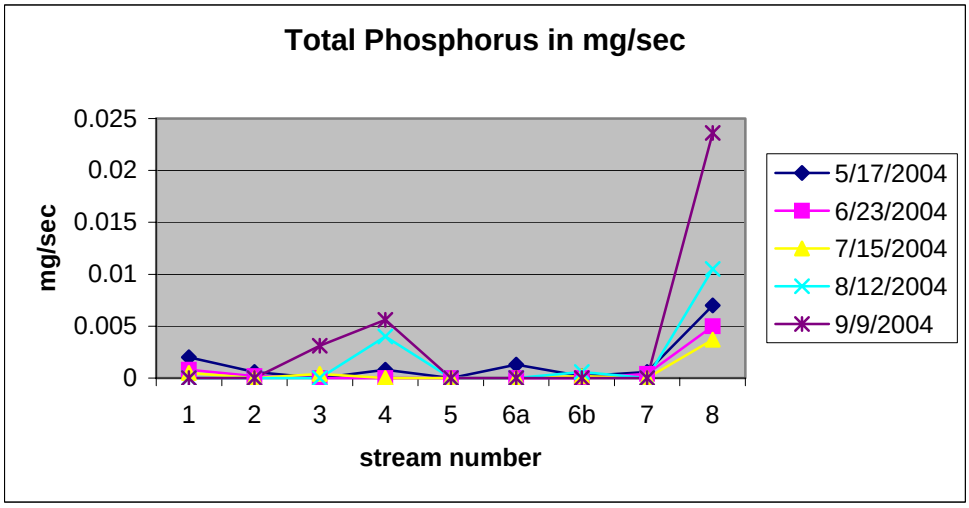
Stream 1 flows into the Head of the Harbor. Stream 2 flows into Meadowi Creek. Stream 3 flows into Polpis East. Stream 4 drains the cranberry bog and flows into Polpis East. Stream 5 drains the swamp near cemetery, and flows into Polpis West. Stream 6a and 6b flow into Polpis West. Stream 7 flows into Quaise. Stream 8 flows into wetland near Life Saving Museum.

Stream 1 flows into Wauwinet. Total Phosphorus was elevated in May. Stream 1 had the highest recorded TP in May for the sample year although the concentration was low (0.002 mg/sec). May has the greatest stream flow for all sample months. Dissolved oxygen is high in May indicating phosphorus is not being released through anaerobic processes but is most likely entering through the watershed.

Streams 2-6b empty into Polpis Harbor. Polpis Harbor had the highest concentrations of total phosphorus.



Total nitrogen was elevated in May, August, and September. Stream 4 and 8 contained the greatest nitrogen concentrations.



APPENDIX 1
Station 1= mooring field
Station 2= Quaise Basin
Station 3= Head of Harbor
Station 4= Nantucket Sound
Station 5= Polpis West
Station 6=Polpis East

Nantucket Harbor 2004
Temperature recorded for harbor stations, April - December

Temperature, degrees celsius

station 1	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	5.7	15.1	18.6	22.4	21.4	19.2	11.6	8.4	6
3	5.6	15	18.6	22.3	21.4	19.2	11.6	8.4	6.2
6	5.5	15	18.5	22.3	21.4	19.1	11.6	8.4	6.2
9	5.4	14.8	18.5	22.2	21.5	19.1	11.6	8.3	6.3
12	5.3	14.5	18.3	22.2	21.5	19	11.6	8.3	6.3
15		14.5	18.3	21.8	21.5	19	11.6	8.3	6.3
			18.1						

station 2	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	6	16	20	23	21.9	19.4	11.3	8.2	6
3	5.9	16	20	23	22	19.4	11.4	8.2	6.2
6	5.8	16	20	22.9	22	19.3	11.4	8.2	6.2
9	5.7	16	20	22.7	21.9	19.3	11.4	8.2	6.2
12	5.6	15.9	20	22.5	21.9	19.3	11.4	8.2	6.2
15	5.3	15.3	20	22.4	22	19.3	11.4	8.2	6.3
18	5	14.8	19.9	22.4	22.1	19.3	11.4	8.3	6.3
21	4.9	14.7	19.9	22.4	21.8	19.3	11.4	8.3	6.3
24	4.8	14.3		21.1	21.8	19.2	11.6	8.3	6.3
27		14.3							

temperature cont'd.

station 3	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	6.3	16.7	19.5	23.2	22.6	19.4	11.3	7.9	6
3	6.2	16.8	19.5	23.2	22.6	19.3	11.3	7.8	6.1
6	6.1	16.6	19.5	23.1	22.6	19.3	11.3	7.8	6.1
9	5.9	16.5	19.6	23.1	22.6	19.3	11.3	7.8	6.1
12	5.8	16.5	19.6	22.8	22.6	19.3	11.3	7.8	6.1
15	5.7	16.3	19.6	22.7	22.5	19.3	11.3	7.8	6.2
18	5.7	16.3	19.6	22.6	22.4	19.3	11.3	7.8	6.2
21	5.6	16.3	19.4	22.5	22.4	19.3	11.3	7.9	6.2
24		16.3						7.9	

station 4	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	5.2	13.3	17.4	21.6	21.5	19.3	11.9	8.9	6.9
8	4.9	13.1	17.3	21.4	21.5	19	11.7	8.5	6.9
17	4.8	13.1	17.3	21	21.4	18.8	11.6	8.5	6.9

station 5	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	5.9	18.1	19.7	23.7	22.1	19.4	10.8	8	5.4
3	6.1	18.1	19.7	23.5	22.1	19.4	11.4	7.9	5.5
6	5.9	18	19.7	23		19.3		8	5.3
7		17.9	19.8	23					

station 6	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	6.1	18.4	20.4	24	22	19.4	11.5	8.4	5.1
3	5.9	18.5	20.5	24	22	19.4	11.5	8.3	5.3
6	5.9	18.4		23.2	21.9	19.3	11.5	8.2	5.6
8		18			21.8	19.4	11.5	8.1	
10.5								8.1	

Dissolved Oxygen recorded for harbor stations

station 1	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	10.22	7.9	6.9	7.1	5.9	5.93	7.54	8.43	8.71
3	10.29	7.93	7.03	7.29	6.11	6.11	7.51	8.48	8.58
6	10.4	7.83	7.02	7.3	6.23	6.04	7.35	8.46	8.61
9	10.36	8.05	6.95	7.24	6.21	6.01	7.38	8.4	8.74
12	10.29	8.01	6.96	7.22	6.2	5.99	7.56	8.29	8.78
15		8	6.94	4.62	6.28	6.02	7.52	8.12	8.82
18			9.56			5.99	7.3	8.23	

station 2	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	9.7	7.63	7.55	6.36	6.45	6.36	7.69	8.65	8.95
3	10.21	7.72	7.42	5.84	6.51	6.32	7.69	8.48	8.9
6	10.36	7.8	7.56	6.21	6.47	6.28	7.68	8.39	8.9
9	10.33	7.76	7.55	6.48	6.24	6.18	7.68	8.3	8.9
12	10.35	7.74	7.61	6.82	6.15	6.17	7.67	8.32	8.89
15	9.77	8.15	7.59	6.7	5.96	6.15	7.76	8.32	8.94
18	9.75	8.1	7.55	6.2	5.19	6.16	7.76	8.32	8.95
21	9.88	8.25	7.4	6.03	5.09	6.03	7.79	8.21	8.95
24	7.88	8.27		5.62	5.43	5.86	7.74	8.25	8.95
		8.33							

station 3	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	9.71	7.56	7.25	6.72	6.63	6.54	7.57	8.46	8.92
3	10.13	7.59	7.24	6.43	6.53	6.57	7.7	8.39	8.86
6	10.29	7.58	7.3	6.57	6.31	6.54	7.66	8.68	8.92
9	10.36	7.59	7.2	6.76	6.42	6.51	7.6	8.66	8.95
12	10.93	7.51	7.41	5.5	6.11	6.45	7.37	8.52	8.96
15	9.78	7.46	7.24	5.66	5.51	6.14	7.58	8.57	8.98
18	9.95	7.4	7.29	5.74	6.04	6.31	7.38	8.66	8.94
21	9.41	7.49	6.81	5.19	5.61	6.02	7.3	8.66	8.92
24		7.51					6.57	8.63	

dissolved oxygen cont'd.

station 4	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	10.55	8.74	7.61	6.52	6.91	6.25	7.82	8.56	8.87
8	10.78	8.64	7.75	6.93	6.67	6.22	7.92	8.36	8.85
17	10.98	8.2	7.82	6.64	7	6.12	7.96	8.4	8.85

station 5	4/7/2004	5/13/2004	6/1/2104	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	10.63	7.02	7.11	5.24	6.21	5.73	7.4	8.25	8.89
3	10.52	7.05	7.2	5.79	6.4	5.7	6.61	8.36	8.99
6	10.38	7.23	7.16	5.6		5.59		8.54	8.49
7		7.97	7.21	5.54					

station 6	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	10.07	6.95	6.91	5.99	6.04	5.91	7.41	8.49	9.4
3	9.94	7.03	6.03	6.79	6.27	5.73	7.46	8.27	9.36
6	10.34	7.08		6.14	6.27	5.65	7.47	8.19	9.11
8		7.19			5.84	5.42	7.39	8.15	
								7.96	

Salinity recorded for harbor stations

station 1	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	30.9	31.3	30.8	31	30.6	32	31.7	31.9	31.4
3	31	31.3	30.8	31	30.7	32	31.8	31.9	31.4
6	31.1	31.4	30.8	31	30.7	32	31.7	31.9	31.5
9	31.2	31.3	30.8	31	30.7	32	31.7	31.8	31.5
12	31.2	31.3	30.8	31	30.7	32	31.7	31.9	31.5
15		31.3	30.9	30.9	30.7	32	31.8	31.9	31.5
18			30.8			32	31.8	31.9	

salinity cont'd.

station 2	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	30.2	31.3	30.8	31.1	30.8	32	31.4	31.7	30.8
3	30.3	31.3	30.8	31.1	30.8	32	31.4	31.7	30.8
6	30.2	31.4	30.8	31.2	30.9	32	31.4	31.7	30.8
9	30.3	31.3	30.8	31.1	30.8	32	31.4	31.7	30.8
12	30.5	31.3	30.8	31.1	30.9	32	31.4	31.7	30.8
15	31.2	31.3	30.8	31.2	31	32	31.5	31.7	30.8
18	31.5	31.3	30.8	31.1	31	32	31.5	31.8	30.8
21	31.5		30.8	30.9	31	32	31.5	31.9	30.9
24	31.5			30.9	31	32	31.5	32	30.9
27									

station 3	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	30.1	30.6	30.7	31.2	31	32.1	31.3	31.5	30.5
3	30.2	30.6	30.7	31.2	31	32.1	31.3	31.5	30.5
6	30.2	30.6	30.7	31.2	31	32.1	31.3	31.5	30.5
9	30.2	30.7	30.7	31.2	31	32.1	31.3	31.5	30.5
12	30.2	30.7	30.7	31.2	31	32.1	31.3	31.5	30.5
15	30.3	30.7	30.9	31.2	31	32.1	31.3	31.5	30.5
18	30.4	30.8	30.8	31.2	31	32.1	31.3	31.5	30.5
21	30.5	30.8	30.8	31.2	31		31.3	31.5	30.5
24		30.9							

station 4	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	31.4	31.3	30.9	31.2	30.9	32	31.8	32	31.8
8	31.4	31.4	30.9	31.2	30.7	32	31.8	32	31.8
17	31.4	31.4	30.9	31.1	30.7	32	31.8	32	31.8

station 5	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	28.1	30.3	30.5	30.9	30.4	31.3	28.5	30.8	30.3
3	29.4	30.4	30.5	30.9	30.5	31.7	30.3	30.8	30.2
6	29.8	30.4	30.5	31		31.8		31.3	30.2
7		30.5	30.5	31					

salinity cont'd.

station 6	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
0	26.9	30.4	30.4	30.8	26.5	31.8	30.9	30.7	30.3
3	29.1	30.4	30.4	30.9	30.6	31.8	30.9	30.9	30.5
6	29.8	30.4		31	30.5	31.8	30.9	31	30.7
8		30.4			30.5	31.8	31.2	31.1	
10.5								31	

Secchi Depth recorded at haror stations

	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
station 1	10	10	16.5	9	7.83	8	11	18	9.5
station 2	13	13	22.16	7	7.83	10	14	19	9
station 3	13	9	22.25	5.16	6.5	10	11	23	11.5
station 4	11	8	9	9	9	9.5	10	17	10
station 5	7	6.5	7.08	7.08	3	5.16	3.5	6	5.66
station 6	6.5	8	2.16	4	7	7.5	7.75	10.5	6

Nitrate-N recorded for harbor stations

	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
station 1	nd	nd	nd	nd	0.02	nd	nd	0.01	0.01
station 2	nd	nd	nd	nd	0.03	nd	nd	nd	0.01
station 3	nd	nd	nd	nd	0.07	nd	nd	0.01	0.01
station 4	nd	nd	nd	nd	0.01	nd	nd	nd	0.01
station 5	nd	nd	nd	nd	0.04	nd	nd	nd	0.02
station 6	nd	nd	nd	nd	0.02	nd	nd	nd	0.01

TKN recorded for harbor stations

	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
station 1	0.28	0.42	0.42	0.28	0.42	0.42	0.28	0.28	0.42
station 2	0.28	0.56	0.42	0.42	0.42	0.42	0.28	0.28	0.42
station 3	0.28	0.28	0.42	0.42	0.42	0.42	0.42	0.42	0.42
station 4	0.42	0.28	0.42	0.42	0.42	0.56	0.42	0.42	0.56
station 5	0.28	0.7	0.56	0.42	0.42	0.56	0.42	0.28	0.28
station 6	0.28	0.42	0.42	0.42	0.42	0.42	0.42	0.28	0.28

Total Nitrogen for harbor stations

	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
station 1	0.28	0.42	0.42	0.28	0.44	0.42	0.28	0.29	0.43
station 2	0.28	0.56	0.42	0.42	0.45	0.42	0.28	0.28	0.43
station 3	0.28	0.28	0.42	0.42	0.49	0.42	0.42	0.43	0.43
station 4	0.42	0.28	0.42	0.42	0.43	0.56	0.42	0.42	0.57
station 5	0.28	0.7	0.56	0.42	0.46	0.56	0.42	0.28	0.3
station 6	0.28	0.42	0.42	0.42	0.44	0.42	0.42	0.28	0.29

Total Phosphorus for harbor stations

	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
station 1	nd	0.018	nd	nd	0.031	nd	nd	nd	nd
station 2	nd	0.018	nd	nd	0.039	nd	nd	0.029	nd
station 3	nd	0.053	nd	nd	0.039	nd	nd	0.016	nd
station 4	nd	0.044	nd	nd	0.022	nd	nd	0.022	nd
station 5	nd	nd	nd	nd	0.046	0.017	nd	0.055	nd
station 6	nd	0.035	nd	nd	0.053	nd	nd	0.046	nd

Temperature

	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
station 1	5.5	14.8	18.4	22.2	21.4	19.1	11.6	8.4	6.2
station 2	5.4	15.3	20	22.4	21.9	19.3	11.4	8.2	6.2
station 3	5.9	16.4	19.5	22.9	22.6	19.3	11.3	7.8	6.1
station 4	4.9	13.1	17.3	21.3	19	19	11.7	8.6	6.9
station 5	5.9	18	20.4	23.3	19.4	19.4	11.1	8	5.4
station 6	5.9	18.3	19.7	23.7	19.4	19.4	11.5	8.2	5.3

Dissolved Oxygen

	4/7/2004	5/13/2004	6/21/2004	7/7/2004	8/18/2004	9/28/2004	11/2/2004	11/23/2004	12/13/2004
station 1	10.3	7.9	7.3	6.8	6.1	6	7.4	8.3	8.7
station 2	9.8	7.9	7.5	6.2	5.9	6.1	7.7	8.3	8.9
station 3	10.1	7.5	7.2	6.1	6.1	6.4	7.4	8.6	8.9
station 4	10.7	8.5	7.7	6.7	6.8	6.2	7.9	8.4	8.8
station 5	10.5	7.3	7.1	5.5	6.3	5.6	7	8.4	8.8
station 6	10.1	7	6.5	6.3	6.1	5.6	7.4	8.2	9.3

Water Quality summary 2004

Table 2: Nutrient recorded in parts per billion

March-April

	1999	2000	2001	2002	2003	2004
NO3	20	31	46	20	46	0
TP	35	3	9	27	455	0
TN		20	10	32	37	28

May

	1999	2000	2001	2002	2003	2004
NO3	27	70	43	6		0
TP	38	18	18	48		29

July

	1999	2000	2001	2002	2003	2004
NO3	90	20	16	0	0	0
TP	55	41	36	23	31	0

August

	1999	2000	2001	2002	2003	2004
NO3	60	10	13	3	33	40
TP	282	23	70	54	54	36

September

	1999	2000	2001	2002	2003	2004
NO3	na	47	63	na	13	0
TP	na	58	171	na	111	0

ave d.o.

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
site 1	10.3	7.95	7.3	6.8	6.1	6.1	7.5	8.3	8.7
site 2	9.8	7.9	7.5	6.2	5.9	6.2	7.7	8.4	8
site 3	10	7.5	7.2	6.1	6.1	6.4	7.4	8.6	8.9
site 5	10.5	7.3	7.1	5.5	6.3	5.7	7	8.4	8.8
site 6	10.1	7	6.5	6.3	6.1	5.6	7.4	8.2	9.3

ave temp

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
site 1	5.5	14.8	18.4	22.2	21.5	19.1	11.6	8.3	6.2
site 2	5.4	15.3	20	22.4	21.9	19.3	11.4	8.2	6.2
site 3	5.9	16.4	19.5	22.9	22.5	19.3	11.3	7.8	6.1
site 4	4.9	13.2	17.3	21.3	21.5	19	11.7	8.6	6.9
site 5	5.9	18	19.7	23.3	22.1	19.4	11.1	8	5.4
site 6	5.9	18.3	20.4	23.7	21.9	19.4	11.5	8.2	5.3

ave salinity

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
site 1	31	31.3	30.8	31	30.7	32	31.7	31.9	31.5
site 2	30.8	31.3	30.8	31	30.9	32	31.4	31.7	30.8
site 3	30.9	30.7	30.7	31.2	31	32.1	31.3	31.5	30.5
site 4	31.4	31.4	30.9	31.2	30.8	32	31.8	32	31.8
site 5	29.1	30.4	30.5	31	30.4	31.6	29.4	30.9	30.2
site 6	28.6	30.4	30.4	30.9	30.5	31.8	30.9	30.9	30.5

secchi

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
station 1	10	10	16.5	9	7.83	8	11	18	9.5
station 2	13	13	22.2	7	7.83	10	14	19	9
station 3	13	9	22.3	5.16	6.5	10	11	23	11.5
station 4	11	8	9	9	9	9.5	10	17	10
station 5	7	6.5	7.08	7.08	3	5.16	3.5	6	5.66
station 6	6.5	8	2.16	4	7	7.5	7.75	10.5	6